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ach items as transformer tanks ove railroads were addressed—use 6" less than required for a wire or conductor of the same voltage or grounding characteristics.

oads and Streets

The closest-approach clearance targets did not change for open supply conductors or rigid live arts crossing above streets and ads. However, coordination of he clearances of supply cables, communication cables, guys, etc., with the clearances required of open live parts and conductors resulted in decreases in clearance requirements of from 6" to 24".

CAUTION

The 1990 clearance table values are required to exist at the time of the conditions which produce he closest approach of the in- allation to the land or water rea to be cleared i.e., the greatest sag conditions. THE TABLE VALUES OF REQUIRED CLEARANCES ARE NOT INTENDED AS INSTALLATION HEIGHTS.

It is particularly critical that the communication attachment heights be carefully planned to consider worst-case sags to keep these cables from contacting trucks traveling down the roadways beneath the cables. By the ame token, it is critical that the upply attachment heights be carefully planned to maintain the required clearances above ground, as well as the required clearances above other facilities on the overhead structures.

> You must allow for sag change after installation. It is your responsibility to attach your facilities high enough that they will not ag below the table values during operation.

Alleys, Nonresidential Driveways, Parking Lots

The changes in these clearances are the same as those above roads and streets except that Footnote 13 to Table 232-1 was changed to delete the 150' span limitation previously used when the code had built in some sag change.

Residential Driveways

Clearances above residential driveways changed dramatically in some respects. Although the clearance for 751V-22kV conductors remained essentially unchanged, the clearances for other open supply conductors increased significantly to be the same as required above a road.

It should be stressed that **not all driveways or portions of driveways leading to a residence are appropriately classified as residential driveways**. Some of these driveways, or portions thereof, are general-use driveways intended for delivery trucks, moving vans, emergency vehicles, etc., while other driveways or other portions may be expected to be used only by residential vehicles (read that as <u>no trucks expected</u> in the portion of the driveway that is underneath the line).

Service drop clearances are the only installations permitted to be placed above a residential driveway at less than the normal road clearances--and then only when the building to be served is not high enough to allow such clearances; see revisions to Footnotes 7 and 13 of Table 232-1. This is a significant change that was required because of numerous service drops being pulled down by moving vans and delivery vehicles.

The new NESC/NEC Coordinating Committee is working on revisions to the NEC to make it compatible with the changes in the NESC for service drop clearances.

Other Lands Traversed By Vehicles

Since these clearances were the same as required above a road, the same changes were made. Notice that there are no footnotes that allow any reduction of clearances in these areas.

Spaces and Ways Subject to Pedestrians or Restricted Traffic Only

This area was completely revised. While an attempt was made to recognize the good history in this area, significant increases were necessary for many of the energized parts and conductors. Two Reference Components were used: eight feet and ten feet.

Eight feet was used as the Reference Component for the messengers, cables and other items contained in the first column of Table 232-1; this recognizes the relatively benign nature of these facilities. While these items may be a mechanical impediment, they do not present a voltage hazard. By using a reference component of eight feet, the resulting clearance locates them above the area traversed by pedestrians and the short vehicles allowed in the area.

Ten feet was used as the Reference Component for all other items, except where the eight-feet value was again considered for limited application (see Footnote 8 of Table 232-1) for service drops to structures too short to provide the normal table values of clearances. Just as with Footnote 7 and residential driveways, Footnote 8 only applies where the structure height will not allow attachment at a level that will achieve the table value of clearance.

Water Areas Not Suitable for Sailboating

This is one of the areas where the coordination of clearances was driven by the existing clearances to cables, etc., not the 750V clearances. Since these clearances still allow for fishing in areas where tall boat masts are not expected, cable clearances were maintained and open supply conductor clearances were increased by 18 inches to achieve coordination. A Reference Dimension of 12.5 feet is used for coordination of all items.

Water Areas Suitable for Sailboating

The clearances in this area were coordinated with the reference vessel heights formerly shown in Footnote 18 of the 1987 Edition. These values are now used in Table 232-3–Reference Heights and also are required by Footnote 18 to determine the required clearances where an overwater obstruction limits the expected height of vessels underneath the line. This results in the same clearances for many of the cables and increased clearances for open supply conductors.

Along and Within the Right-of-Way, But Not Overhanging the Roadway:

A Reference Height of 14 feet was used for lines along roads, streets or alleys, regardless of whether they were in an urban or rural environment. Although the older code editions allowed lesser clearances along rural roads, the newer editions have recognized the problems caused by the sudden changes in the nature of some areas as they have grown. Thus the normal roadway clearances are required within the rights-of-way of roads to allow vehicles to pull off the road during emergencies.

The NESC recognizes that there are some areas alongside roadways in rural areas where there is a cut or fill or other terrain feature of such a nature as to prevent a vehicle from pulling beneath the line. For these areas only, a Reference Dimension of 12 feet is used to clear the highway right-of-way maintenance equipment.

CAUTION

Just because there is a ditch between the roadway and a forest alongside the right-of-way doesn't mean that tomorrow morning you won't find the first tree in the ditch and the loggers trucking the rest of the trees out over it. Category 10 of Table 232-1 is not intended for general use; there should be some serious terrain feature there to invoke its use.

Rule 233: Clearances of Wires, Conductors and Cables Carried on Different Supporting Structures

Rule 233 was one of the harder areas to coordinate with other clearance rules because the basic table for vertical clearance values, Table 233-1, was so "chunky" in its construction. The basic idea behind the rule is to keep conductors carried on different supporting structures from coming too close to each other as they pass by one another, either vertically or horizontally.

The rule provides clearances which are to be in effect when the conductors are at their closest approach AFTER conductor movement due to ice, thermal expansion or wind displacement. This may require checking summer conditions, with the upper conductors at maximum operating temperature and the lower conductor at ambient temperature, and winter conditions, with the upper conductor loaded with ice and the lower conductor at ambient temperature, or some other set of potentially conflicting conditions, depending upon the given local conditions.

In addition, extra clearances have always been provided when lower voltage conductors or cables, including communication, are in potential conflict with conductors of a higher class of voltage. The addition of these extra clearances was not uniform and this caused problems in changing the table during the 1990 revisions.

There were two reasons why the break point of 15kV was moved to 22kV in the 1984 Edition. The first was to recognize that 34.5/19.9kV was not appreciably different from 24.9/14.4kV from a safety standpoint. The second was that the difference between 22kV and 50kV is 28kV which, when multiplied by the voltage adder of 0.4"/kV yields a one-foot voltage adder to 50kV and allowed a smooth, electrically related transition from the distribution voltage level to the transmission voltage level for the tables of Rules 232 and 234, rather than the previous jump of two feet. Table 233-1 values wer left untouched at that time.

When the complete review of clearances occurred during the 1990 revisions, Table 233-1 presented a difficult problem in coordination because the jump were still two feet. As a tem-

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rary measure, until more ldy, the 22-50kV column was removed from the table, but the 22-50kV row was left in Table 233-1 to preserve the clearance increase when a distribution circuit crossed over a subtransmis- on circuit.

Thus, the voltage adder of 0.4"/kV applies above 22kV for a circuit in the upper position and it applies above 50 kV for a cir- uit in the lower position at a ossing. See the fourth row and ie last column of Table 233-1. As a result, you may find a different voltage adder for a transmission circuit in the upper position than you will find if it is in the lower position.

Remember, if the upper line exceeds 22kV, if the lower line exceeds 50kV, or if both exceed their respective table limitations, then the basic clearance value from the table must be increased r the appropriate voltage der(s).

Rule 234: Clearances to Buildings, Bridges and Other Installations

This part of the code covers lines which pass by but do not attach to supporting structures of other lines; buildings; bridges; signs, antennas, tanks and other installations; swimming areas, including platforms; etc. Rule 234 cognizes the clearances re- uired for personnel to repair and maintain these installations, as well as the clearances required when personnel are not expected to be between the lines nd the subject utility facilities.

Table 234-1: Buildings and Other Installations Except Bridges

ie vertical clearances of Table 4-1 apply under the same closest-approach conditions as the vertical clearances of Rule 232. However, the horizontal clearances are required to be checked two ways--with and without deflection from a six-pounds-per-square-foot wind on the conductors.

The horizontal clearance values in Table 234-1are required with the conductors at rest, without wind deflection; see Rule 234C1a. These values are based upon a Reference Dimension of 3.0 feet.

The wind-deflected clearance requirements of Rule 234C1b and Footnotes 9 and 10 of Table 234-1 apply to open supply conductors. It is not expected that building exteriors will be maintained during a 48 mph wind; consequently, a Reference Dimension of 0.0 ft was used to develop the wind clearance values.

Thus, if the conductors are installed in such a way that the horizontal deflection under a 6 pounds per square foot wind is greater than 3.0 feet, the required clearance at rest would increase above the table value by the amount that the horizontal deflection exceeds 3.0 feet.

If you examine Table 234-1 carefully, you will see that rigid live parts of 0- 750V are in the same column as supply cables of 0-750V meeting Rule 230C2 or 230C3; that fits the coordinated system. The horizontal clearances follow the system BUT the vertical clearances do not; therein lies the problem. The vertical clearances were deliberately set to continue to allow triplex at the 3.5 feet level, which does not meet the system. Because of the table construction, the unintended result of reducing the clearance of rigid live parts of 0-750V also occurred. A similar problem occurred for the horizontal clearances from signs, billboards, tanks and other installations.

CAUTION

A Temporary Interim Amendment is now in the consideration process to move the vertical clearances for rigid metal parts of 0-750V from 3.5 feet to 5.5 feet above signs (and the other items upon which an adult is not expected to walk erect) and to 10.0 feet above buildings (and other installations upon which adults are expected to walk erect) where the roof is not accessible to pedestrians. The horizontal clearance to signs would move to 5.0 feet. This meets the clearance coordination system.

A significant increase in vertical clearances occurred for open supply conductors above roofs not accessible to pedestrians. While the ten years of accident data that was reviewed by the working group did not indicate a need to increase the vertical clearances required for workers to maintain the roofs, adherence to the coordinated system indicated the need for a significant increase. Since there was no reason NOT to do so, the clearance required for open supply conductors was increased to comply with the coordinated uniform clearance system.

Table 234-2: Bridges

The clearances for bridges were also revised to be consistent with the new coordinated clearance system. The required clearances recognize the differences in potential problems caused by conductors which do not attach to the bridge, as opposed to those with fixed locations. Also recognized are the difference in activities and control expected for the areas of a bridge exposed to the public and those only exposed to professional bridge maintenance personnel.

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The Reference Component for conductors that are attached to the bridge structure is 1.0 feet, regardless of the location of attachment. Where the conductor is not attached, the Reference Component varies from 8.0 feet above bridges to 3.0 or 2.0 feet beside, under or within the bridge structure, depending upon whether the area is accessible or not accessible to the public, respectively.

It shouldn't come as a great shock to find that the clearances from areas on a bridge that are accessible to the public are the same as those required from buildings. Note that the vertical clearance above an accessible area on a bridge is the same as above a roof that is NOT accessible to pedestrians; this is because the activity expected by the public on a bridge is limited in scope. Areas of a bridge that are accessible to vehicles are required by Footnote 1 to meet the clearances of Rule 232.

Table 234-3: Swimming Areas

Examination of the existing clearances of Table 234-3 showed that the values to a diving platform or tower were very close to matching the coordinated system, but the values to the water level and edge-of-pool level varied greatly from the system. The Reference Component of 12.5 feet for the diving platform/tower was derived by removing the 18" of included sag change from the original value of 14.0 clearance for the guys, etc.

CAUTION

The horizontal clearances are required when the conductors are displaced by a six pound per square foot wind toward the area under consideration. Thus, the horizontal clearance when the conductor is at rest will be greater than these values by the amount of wind deflection.

Revision of the clearances above the edge of pool were based upon the expected use of pool skimmers and rescue poles of 16.0 feet in length. Since that was the basis for the original clearances of noninsulated conductors, these clearance values did not change much. However, the original table values for guys, triplex service drops, etc., were originally allowed to be significantly less in order to be less of a burden when trying to serve residences with backyard pools.

Because of concern about the opportunity for people using rescue poles or skimmer poles to be themselves knocked into the pool when catching one end of the pole on a service drop or guy, these values were increased to meet the coordinated clearance system. The Reference Component of 20.5 feet allows clearance for a 16 feet rescue pole to be lifted from a fence storage location and pivoted directly overhead to the water.

As a practical matter, these changes will limit the ability to serve some residences aerially from rear-lot-line distribution lines. In congested spaces where pools are located in backyards, the distribution lines themselves may have to be installed at higher levels.

Figure 234-3: Grain Bins Filled by Portable Augers, Etc.

A new Rule 234F was added in the 1990 Edition to specify clearances to grain bins. Although all grain bins must allow clearance above the probe ports to allow for testing the temperature inside, the grain bins with permanent filling systems are essentially treated like a building otherwise. It is the bins that are filled by portable augers, conveyors or elevators that require special clearances to allow the augers, etc., to be positioned a[illegible] removed.

The portable augers typically have a drop tube hanging from the top end. To position the auger over the filling port on to[illegible] of the bin, the auger is raised high enough for the fill tube to clear the top of the bin, and then the auger is pushed into position and lowered to insert the fill tube into the filling port. To remove the auger, it is first raised high enough for the fill tube to clear and then pulled back clear of the side of the bin to be lowered for transport to another location. The manufacturers of portable augers make it quite clear that they are not built to be transported in the raised position; they are top heavy and will fall over.

The 18 feet of vertical clearance above the level of the top probe port on the grain bin that is required for using the temperatu[illegible] probe also works for providing the vertical clear ance needed for positioning of the portable auger fill tube above the filling port.

On any loading side of a grain bin (which may be completely around a single bin if there is no limitation to the use of the portable auger), no conductor is allowed lower than a level equal to the height of the bin plus 18 feet within a horizontal distance from the side of the bin that is also equal to the height of the bin plus 18 feet. In other words, higher bins require the use of longer augers and, thus, greater horizontal clearances for the supply conductors near the bin.

Beyond this area, the vertical clearance above grade is allowed to decrease by one foot for every 1.5 feet of additional horizontal clearance from the side of the bin. This provides for the slope of the auger when it has been raised for positioning above th[illegible] filling port.

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CAUTION

Unlike buildings which are not expected to be maintained in high winds, grain bins may be filled during high winds, especially when the wind direction is toward to the bin along the axis of the loader, not across the loader. Because there can be significant wind deflection of the conductor, especially for long spans of light conductor frequently found in rural areas, the horizontal clearances of Figure 234-3 are required when the conductor is displaced toward the bin by a six pounds per square foot wind.

Rule 234F recognizes that land use constraints often dictate placement of the various facilities used on a property and allows consideration of portions of grain bins as nonloading sides where they are so designated by agreement.

Potheads, Bushings, Arresters, Jumpers, etc.

Rule 234J was moved from Section 28. Energized parts are required to have the same horizontal clearances as required for conductors of the same voltage when they are at rest, as well as the same closest-approach vertical clearances, as specified in Rules 234C and 234D. Clearances to equipment cases are consistent with their treatment in Rules 232.

Rule 235: Wires, Conductors, or Cables Carried on the Same Supporting Structures

Rule 235 specifies the clearances at the structure required between wires, conductors and cables carried on the same supporting structures, i.e., carried on the same line. These clearances at the structures do two things: (a) assure that the items are mounted far enough apart to allow sufficient clearance in the span to limit the opportunity for contact; and (b) support the climbing and working space requirements of Rules 236, 237 and 238.

Line Conductors - Diff. Circuits

Rule 235A3 was modified for clarity. The voltage of concern is the greatest one that can exist between the two items in question. For two phases of the same voltage level that are in phase, or nearly in phase, the voltage difference between them may be greater when one of them is taken out of service and grounded. Phase relationships can make a large difference in the voltage potential between two conductors; where the phase relation ship is unknown or expected to change from time to time, then a 180° out-of-phase relationship is appropriate.

CAUTION

The phasor-difference voltage is required to be used in all cases where some other voltage is not specified. For example, Table 235-5 specifies the use of phase-to-ground voltages to classify circuits only; inside the table where you are required to calculate a clearance from the formula (16 plus 0.4 per kV over 8.7kV), the phasor difference voltage is to be used.

Example: for a 19.9kV circuit above a 7.2kV circuit with unknown phasor relationships, the clearance is calculated as follows:
19.9 + 7.2 - 8.7 = 18.4kV
(18.4 • 0.4 = 7.4) + 16 = 23.4"

Rule 235B specifies the horizontal clearance at supports. **The MOST COMMON MISTAKE with this rule is to play accountant and only look at the first table that looks like it applies,** without reading the rule to see what else applies. As a result, some designers unfortunately look only at the requirements of Table 235-1 and do not check the requirements of Table 235-2 or Table 235-3, whichever is applicable. The result is damaged conductors and poor reliability.

Rules 236, 237 and 238: Climbing Space and Working Space

These rules remain essentially unchanged, except for the movement of Rules 237E and 237F to this location from Section 28.

Traffic signals were added in Rule 238C & D and Table 238-2 to recognize signals that are directly mounted to utility poles.

Rule 239: Vertical and Lateral Facilities

The front of this rule was revised for clarity. The previous language had been around long before plastic conduits became available and some of the wording was no longer clear. The original wording was intended to make it clear that a metallic supply conduit could be run in the communication space under certain circumstances, as opposed to requiring a wood molding, the only other alternative at the time.

Rule 239A allows grounding conductors, 230E1 neutrals, 230C1 supply cables and conduits of all types to be placed directly upon the structure. This includes URD (underground residential distribution) cables with effectively grounded concentric neutrals, regardless of the type of jacket, if any, covering the concentric neutral conductors.

READER'S RACK

Clearance Reductions -- Footnote 13 to Table 232-1

How do you apply Footnote 13, Table 232-1 to Item 2 – Roads, Streets, Alleys, Nonresidential Driveways, Parking Lots, and Other Areas Subject to Truck Traffic and Item 9 – Roads, Streets and Alleys?

The reductions allowed in Footnote 13 do not apply over or alongside roads and streets, but they may be used along or over areas where high speeds are not expected, if they are needed to meet other requirements of the code. As with other clearances, they are "closest approach" clearances. Thus, they must be installed high enough to take into consideration expected sag changes, pole movement, etc., so that the conductors or cables never violate the clearance values.

Driveway Clearances -- Footnote 7 to Table 232-1

Footnote 7 provides relief from the clearances stated in Table 232-1 for service drops over residential driveways by stating "Where the height of attachment to a building or other installation does not permit service drops to meet these values, the clearance may be reduced to the following:" Is it the intent of the NESC to place the burden of meeting clearances for service drops over residential driveway on the home owner? Footnote 7 is quite clear that the building attachment is the operative condition in determining whether to meet the clearances of Table 232-1 or Footnote 7. How is a utility to administer these driveway clearances? That is, are utilities only concerned that service drops satisfy the clearances of Footnote 7, or are utilities to require home owners to raise their house service attachments to comply with the clearances of Table 232-1?

This change resulted from numerous encounters of moving vans and other vehicles of similar height with service drops. Obviously many of these encounters would not have occurred if the utility planner had remembered that not all driveways leading to or beside residences are "residential" driveways--many are general-use driveways expected to be utilized by moving vans, delivery trucks, emergency vehicles and the like.

In many cases, the beginning of a driveway to a residence is a general-use driveway required to meet Item 2, Table 232-1, rather than Item 3, because they are expected to be subject to truck traffic (defined in Footnote 21 as vehicles in excess of eight feet in height), while the portion of the driveway beside or to the rear of the home may be considered as a residential driveway. Even in this case, however, experience has taught us that clearances less than the values in the table are not appropriate if they are practical to achieve. As a result, the height of two-story structures and gable-roofed, single-story structures is expected to be utilized.

The NESC/NEC Coordination Committee is looking at NEC changes to match the new NESC requirements. Until such changes are made in the NEC, it can be useful to meet with building inspectors and contractors to explain these changing requirements. Under the NESC, if the room is on the building to achieve the Table values, either it must be used for that purpose or the service must be run underground. Just because the local electrician ran a ten foot weatherhead, there is no excuse.

Rule 232-A-1.

Does a non-current carrying overhead ground wire need to be figured at 120° F for vertical clearances?

Yes, that is <u>one</u> of the condition to be checked. Rule 232A requires the higher of 120° F or maximum operating temperature to be used. On the right summer day in the right place, any wire in full sun can approach 120° F; experience has shown that the value is not unreasonable.

Supply Crossing Clearances --Table 233-1.

Why do <u>open supply conductors of over 750 volts to 22 kV</u> only require two feet over <u>open supply conductors 0 to 750 volts</u>, while <u>supply cables 0 to 750 volts meeting Rule 230C2 or 230C3</u> require four feet over <u>open supply conductors 0 to 750 volts</u>?

This change was made in the 1977 Edition. It is one of several items which pay a two foot clearance penalty when placed in the <u>upper</u> position at a crossing. This table is under review for a 1993 rewrite to reflect modern experience with these and other installations.

Above-Ground Gas Tank, Gas Pumps, Vents of Underground Gas Tank

What are the required vertical and horizontal clearances of overhead primary or secondary conductors from the following items: an above ground gas tank, gas pumps, underground gas tank vents extending abo ground (i.e. 11 feet high)?

Under the NESC, Rule 234 treats these items as an "other installation" or a "tank." If the gas tank is small enough that adults are not expected to walk erect upon it, it fits Category 2 of Table 234-1. If adults are expected to walk erect upon it, it is treated as a building under Category 1. Depending upon the size of a gas pump or gas tank vent relative to the size of the vehicles expected nearby, the required vertical clearance may be governed by Rule 232 for the of type or area in which it is located or by the clearances of Table 234-1, Category 2 above the pump or vent stack.

Note that ANSI/NFPA 30, Flammable and Combustible Liquids Code, requires a vent pipe height of 12 feet above grade, not 11 feet. NFPA 30 also classifies areas within five feet in any direction from the open end of the) as an NEC Class I, Division area and the area between five feet and ten feet in any direction from the open end of the vent as an NEC Class I, Division 2 area. As a result, if a conventional overhead distribution line phase conductor had a worst-case vertical clearance of eight to ten feet, it would meet the NESC requirement, but cause the vent pipe to violate the requirement placed upon it by NFPA 30 and the NEC, NFPA 70. If the clearance over ten feet, both facilities meet their applicable requirements.

Gas Meters and Electrical Meters

What is the required clearance between the natural gas meters and electrical meters on a residential or commercial building?

This is not covered by the NESC, but by building code requirements. NFPA 30, Flammable and Combustible Liquids Code, classifies the area within three feet in any direction from a gas meter as being an NEC Class I, Division 2 area. The NEC, NFPA 70, Article 501-3(b) requires electrical enclosures of equipment within that area to be rated for Class I, Division 1 use if the circuits under normal use can "release sufficient energy to ignite."

Telco Drop Wire

One telephone company shows their drop wire attached to the customer power service mast with a one foot spacing to the bottom wire drip loop. Does the code allow this?

NESC Rule 235C1, EXCEPTION 3 allows such a 12 inch vertical clearance, as does NEC Article 800-10(a)(4).

Riser Clearance on Joint-Use Pole

On a joint use pole, what is the minimum vertical clearance allowed between the top of a conduit riser which contains 600 volt URD service drop cable and another utility's communication cable located below?

Forty inches. See Rules 239G3 and 239G1.

Midspan Triplex-to-Comcable Clearance

I interpret the minimum midspan clearance of triplex and quadruplex cables from communication conductors to be 75% of that required at the supports per Rule 235C2b(1)(a).

Please explain why triplex and quadruplex cable per Rule 230C3 is not included in Rule 235C2b(1)(a) EXCEPTION. In reviewing your DANESC tape for Rules 230C1, 230C2 and 230C3, you explain that when the conductor insulation fails on this cable, the bare effectively grounded neutral will, for all practical purposes, ground out the exposed bare conductor thereby taking it out of service. It would appear that triplex and quadruplex cable, from this standpoint, could be included with 230E1 or bare neutral.

The difference is the lack of a grounded sheath or shield on the 230C3 cables. While they will eventually take themselves out of service after the insulation fails, they may not do so immediately if hit by a ladder, etc. In addition, the exterior of a 230C3 cable is not grounded and can exhibit a limited voltage for an extended time, especially at low voltages.

Rule 235C2b(3), Exception

Is Rule 235C2b(3), EXCEPTION intended for spacer cable type lines only? Please explain.

It does not apply to spacer cable; it applies to neutrals only. Energized phase conductors supported on insulated spacers do not meet the requirement of the EXCEPTION; they must comply with Rule 235C2b(1)a, b(2) and b(3).

Next issue we will answer more question's on clearances in our *Reader's Rack* column.

DANESC UPDATE™ is published by Allen L. Clapp, P.E., R.L.S., President of Clapp Research Associates, P.C., a small consulting engineering firm serving utilites and industries, and Clapp Research, Inc., which prolvides training materials.

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From the Editor...

This issue continues with our special clearances set. Included is a comparison of the real clearance requirements of the old method and the new coordinated, "don't ever come closer than" method of determining required clearances. See page 3 for an introduction to these comparisons.

Strengths & Loadings Problems

Recently we have found that a large number of engineers are using the unmodified output from some of the fine conductor sag and tension programs now available for use on the personal computer. It comes as a shock to them to learn that **using the unmodified, raw output of sag and tension programs virtually guarantees that they will have NESC violations.**

The output of these programs gives sags and tensions that, if actually installed, will produce the maximum allowable tension on the conductor at the code limit condition. Since it is virtually impossible to install a conductor exactly at any tension or sag, you guarantee that your installers will violate the NESC in many installations if you do not back off further from the tensions initially given by the programs.

Even worse than giving installers the wrong target data is letting them install conductors so that they "look good." How many times have you heard someone say they put up conductors to "look good?"

In the next issue, we will explore what happens to tensions and clearances when the conductor is installed incorrectly. In addition, we will present tables with the wind deflection of commonly used conductors under the 6 #/sq ft wind required by Rule 234, and we will discuss potential problems caused by adding aluminum phase conductors to an existing copper-conductored line.

Grounding Update

The International Association of Electrical Inspectors has released the 4th Edition of Soares' Grounding Electrical Distribution Systems for Safety. We use this book in a number of our seminars because it is one of the best small books on grounding that we have seen.

Intended for electrical inspectors dealing with the distribution systems of large industrial and commercial facilities, it contains many diagrams, explanations, and discussions that are useful to those interested in the grounding of electrical supply and communication utility systems.

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continued on next page

FROM THE EDITOR

Disturbing News

As we went to press, we learned of the untimely death of **Arthur Morrison of Mississippi Power Company**. Art was the father of the modern day safety outreach programs being adopted by major electric utilities all across the country.

Art has rightly been called the "Johnny Appleseed" of the public safety business. For example, he convinced Doug Campbell, President of Coast Catamaran Corp. (producer of Hobie Cat sailboats), to work with the industry; if you ask, CCC will give you mailing labels for every owner of record residing in your Zip Code areas so that you can send your own message.

It is amazing what a little cooperation between interested parties can do. Art also obtained permission to alter the Canadian crane booklet to fit your needs as a safety handout for crane operators working around energized lines. I enjoyed working with him on that. Mississippi Power has permission to allow other utilities to use that revised crane booklet, and many of you have taken advantage of that opportunity.

Art's untiring sale of the safety message to the utility community has resulted in increasing, proactive use of these handouts and other public safety programs a… information across the country. From my travels I can tell you that proactive public safety outreach programs are working, and many of these programs are th… direct result of Art Morrison.

The efforts of Art Morrison have already saved countless lives. He was a good friend and a truly selfless man, one of those rare individuals with the set of person values that you hope will be present in your offspring. We shall all miss him very much.

Allen Clapp

SEMINAR ON
INVESTIGATING AND DEFENDING UTILITY CONTACT ACCIDENTS

June 17-20, 1991

Raleigh, North Carolina

sponsored by
Clapp Research Associates, P.C.

At the request of several clients, we will be presenting the information you need to know when you are defending yourself after someone has adversely contacted your facilities. **Do you meet the code requirements? What standards apply to the behavior of those contacting your facilities?**

These are the questions that we will answer with respect to:

- cranes, scaffolds & ladders
- cars
- dump trucks
- antennas, roofers, gutter & siding
- house movers
- tree trimmers
- grain bins, billboards
- readily climbable structures

The applicable NESC Rules, OSHA regulations, AASHTO guides, NEC requirements and other standards will be covered with respect to clearances, grounding, system protection, indoor wiring (NEC) vs utility system wiring (NESC), and work rules. **We will stress the methods and data required to properly measure conductor clearances relative to expected sag changes and to determine code compliance.** Investigative techniques and other tricks of the trade will be illustrated in the context of different accident types.

FOR MORE INFORMATION, CALL 919/782-7745.

COMPARISON OF 1987 AND 1990 CLEARANCE SYSTEMS

This discussion will amplify the discussion of clearance rule changes contained in the previous volume of DANESC **UPDATE™**.

The main difference between the two methods is that older codes required conductors and cables to be at some level at 60 °F. The clearance values included within the 1987 tables included up to 18 inches to allow for additional sag below that level under ice loading conditions or thermal loading conditions. These values were good for a limited set of basic span lengths that varied with the loading district. Additional clearance adders were required for longer spans or high temperature operation.

The new 1990 method gives you the real value that is not to be breached under any circumstances. No allowances for sag changes are included in the new table values.

Be careful of what you think you see; it may not be that at all. For example, it would appear that there have been drastic decreases in the required clearances for telephone and CATV cables. In fact, the mounting position for these cables, as well as their initial sags may not change—remember, NOW YOU ARE RESPONSIBLE for allowing for expected sag changes for ice loading and thermal loading.

The extensive set of tables that follows will illustrate the changes from the 1987 values to the 1990 values that resulted from the changes in NESC Tables 232-1, 232-2, 234-1, 234-2 and 234-3.

Vertical Clearances

For each of the comparisons, there are three columns. The **first column** shows the **1987** clearance table value. These values were required to exist at 60°F and included an allowance for changes in sag under icing or 120°F conditions.

The **second column** shows where the conductor, wire or cable meeting the **1987** Edition might be under ice loading or 120°F operation if conductors had the full 18" sag change included in the table value, cables changed only 12", and overhead guys changed 6" from 60°F to maximum sag.

The **third column** shows the **1990** value that is to be met under the maximum sag conditions (or minimum sag, if applicable).

Horizontal Clearances

For each of these comparisons, there are also three columns. The **first column** shows the clearance required by the **1987** Edition when the conductor was displaced from rest toward the structure by a 6#/sq. ft. wind at 60°F.

The **second column** shows the clearances required by the **1990** Edition under the same conditions.

The **third column** shows the clearances required by the **1990** Edition with the conductors at rest.

Each of the tables also includes the Mechanical and Electrical Components and the Reference Components included within the 1990 table clearance values. A new Appendix A is included in the 1990 Edition of the NESC to illustrate the differences between the old system and the new one. The Reference Component for the area is added to the Combined Mechanical and Electrical Component for the wire, conductor or cable to produce each table value.

Many of the "closest approach" clearance values did not change from what had been the intended result all along. However, others were found not to be consistent with the basic coordinated system that had been used for most of the early code development. When that occurred, the old values were changed to achieve uniform coordination, unless a valid reason was found to do otherwise. As a result, two reference dimensions occasionally are used.

Where the coordination effort found a lack of coordination between the clearances for secondary voltages or for cables with respect to those required for distribution line phase voltages of 751V-22kV, the general action was to leave the high-voltage facilities where they had been, develop the Reference Dimension accordingly, and coordinate the communication facilities and the lower- voltage conductors and cables with the locations required of the higher voltage facilities.

Thus, in the 1990 Edition, the closest-approach location of the 751V-22kV class of facilities essentially is unchanged from the previous edition, after taking into account the changes in the methodology and removing any included sag change. However, the location of the lesser voltage facilities may have moved slightly to coordinate with the other clearances.

See the discussions included in the last issue of **DANESC™ UPDATE** for more detail.

Clearances Over Land Areas: Rule 232

		Category 1.			Category 2.			Category 2.		
		Clearances Over Railroads			ClearancesOver Roads & Streets			Clearances Over Alleys, Nonresidential Driveways, Parking Lots and Other Areas Subject to Truck Traffic		
NESC Edition		87	87	90	87	87	90	87	87	90
Reference Dimension		22	22	22	14	14	14	14	14	14
Conductor Loading		60°	120° /ice	all	60°	120° /ice	all	60°	120° /ice	all
Clearances From:	**1990 M&E Component**									
Rigid Parts:										
Structures and arms	1	22	NA	NS	15	NA	15	NS	NA	15
Grounded metal	1	NS	NA	NS	15	NA	15	NS	NA	15
Ungrounded metal					Clearances to ungrounded metal are the					
Unguarded Rigid Live Parts:										
0 to 150 V	2	NS	NA	NS	16	NA	16	16	NA	16
151 to 300 V	2	NS	NA	NS	16	NA	16	16	NA	16
301 to 750 V	2	NS	NA	NS	16	NA	16	16	NA	16
751 V to 22 kV	4	NS	NA	NS	18	NA	18	18	NA	18
751 V to 8.7 kV										
8.7 kV to 22 kV										
Communication:										
Insul.cond. and cables	1.5	27	26	23.5	18	17	15.5	18	17[a]	15.5[a]
Other conductors	2	25	26	24	18	16.5	16	18	16.5[a]	16[a]
Messengers	1.5	25	24.5	23.5	18	17.5	15.5	18	17.5[a]	15.5[a]
Surge protection wires	1.5	27	26.5	23.5	18	17.5	15.5	18	17.5[a]	15.5[a]
Guys:										
Grounded portions	1.5	25	24.5	23.5	18	17.5	15.5	18	17.5[a]	15.5[a]
Ungrounded portions	b	25	24.5	b	18	17.5	b	18	17.5[a]	b
230E1 Neutral	1.5	25	24.5	23.5	18	17.5	15.5	18	17.5[a]	18[a]
Supply cables meetings:										
Rule 230C1; any voltage	1.5	25	24	23.5	18	17	15.5	18	17[a]	15.5[a]
Rule 230C2; 0 to 750 V	2	27	26	24	18	17	16	18	17[a]	16[a]
Rule 230C2; over 750 V	2.5	27	26	24.5	18	17	16.5	18	17	16.
Rule 230C3; 0 to 750 V	2	27	26	24	18	17	16	18	17[a]	16[a]
Rule 230C3; over 750 V	2.5	27	26	24.5	18	17	16.5	18	17	16.5
Open supply conductors:										
0 to 300 V	2.5	27	25.5	24.5	18	16.5	16.5	18	16.5	16.5
301 to 750 V	2.5	27	25.5	24.5	18	16.5	16.5	18	16.5	16.5
751 V to 22 kV	4.5	28	26.5	26.5	20	18.5	18.5	20	18.5	18.'
751 V to 8.7 kV	4.5									
8.7 V to 22 kV	4.5									

[a] 15' if span under 150' (1987); 1990 Edition left off the span restriction.

[b] Clearances to ungrounded portions of guys are the same as required for the live conductors or parts to which they are exposed.

NS - Not Specified

NA - Not Applicable

AND 1990 CLEARANCES

ables 232-1 and 232-2

Category 3.			Category 4.			Category 5.			Category 9.			Category 10.		
									Vertical Clearances Along and Within R/W But Not Overhanging Roadway					
Clearances Over Residential Driveways			ClearancesOver Other Lands			Clearances Over Spaces or Ways Accessible to Pedestrians or Restricted Traffic Only			Over Roads, Streets or Alleys			Over Roads in Rural District Where Unlikely That Vehicles Cross Under		
87 60°	87 120° /ice	90 14 all	87 14 60°	87 14 120° /ice	90 14 all	87 9 60°	87 9 120° /ice	90 8/10 all	87 60°	87 120° /ice	90 14 all	87 60°	87 120° /ice	90 12 all
NS	NA	15	NS	NA	15	NS	NA	10	NS	NA	15	NS	NA	13
NS	NA	15	NS	NA	15	NS	NA	10	NS	NA	15	NS	NA	13
same as required for the associated live part														
12	NA	16	16	NA	16	10	NA	12	16	NA	16	13	NA	14
12	NA	16	16	NA	16	12	NA	12	16	NA	16	13	NA	14
13	NA	16	16	NA	16	13	NA	12	16	NA	16	13	NA	14
18	NA	18	18	NA	18	13	NA	14						
									18	NA	18	16	NA	16
									18	NA	18	16	NA	16
10	9	15.5	18	17	15.5	8	7	9.5	18	17	15.5	13	12	13.5
10	8.5	16	18	16.5	16	10	8.6	12	18	16.5	16	13	11.6	14
10	9.5	15.5	18	17.5	15.5	15	14.5	9.5	18	17.5	15.5	14	13.5	13.5
12	11.5	15.5	18	17.5	15.5	15	14.5	9.5	18	17.5	b	14	13.5	b
10	9.5	15.5	18	17.5	15.5	8	7.5	9.5	18	17.5	15.5	14	13.5	13.5
10	9.5	b	18	17.5	b	8	7.5	b	18	17.5	b	14	13.5	b
10	9.5	15.5	18	17.5	15.5	8	7.5	9.5	18	17.5	15.5	14	13.5	13.5
10	9	15.5	18	17	15.5	10	9	9.5	18	17	15.5	14	13	13.5
12	11	16	18	17	16	15	14	12	18	17	16	14	13	14.
15	14	16.5	18	17	16.5	15	14	12.5	18	17	16.5	15	14	14.5
12	11	16	18	17	16	15	14	12	18	17	16	14	13	14
15	14	16.5	18	17	16.5	15	14	12.5	18	17	16.5	15	14	14.5
12	10.5	16.5	18	16.5	16.5	12	10.5	12.5	18	16.5	16.5	15	13.5	14.5
15	13.5	16.5	18	16.5	16.5	15	13.5	12.5	18	16.5	16.5	15	13.5	14.5
20	18.5	18.5	20	18.5	18.5	15	13.5	14.5						
									20	18.5	18.5	18	16.5	16.5
									20	18.5	18.5	18	16.5	16.5

Clearances Over Water Areas: Rule 232A, Tabl

		Category 6.			Cate					
		Clearances Over Water Areas Not Suitable for Sailboating			Clearances Over Water Areas					
					Less Than 20 Acres			20 - 200 Acres		
NESC Edition		87	87	90	87	87	90	87	87	90
Dimension		14	14	12.5	16	16	16	24	24	24
Conductor Loading		60°	120° /ice	all	60°	120° /ice	all	60°	120° /ice	all
Clearance From:	**1990 M&E Component**									
Rigid Parts:										
Structures and arms	1	NS	NA	NS	NS	NA	NS	NS	NA	NS
Grounded metal	1	NS	NA	NS	NS	NA	NS	NS	NA	NS
Ungrounded metal					Clearances to ungrounded metal are the					
Unguarded Rigid Live Parts:										
0 to 150 V	2	NS	NA	NS	NS	NA	NS	NS	NA	NS
151 to 300 V	2	NS	NA	NS	NS	NA	NS	NS	NA	NS
301 to 750 V	2	NS	NA	NS	NS	NA	NS	NS	NA	NS
751 V to 22 kV	4	NS	NA	NS	NS	NA	NS	NS	NA	NS
751 V to 8.7 kV										
8.7 kV to 22 kV										
Communication:										
Insul.cond. and cables	1.5	15	14	14	18	17	17.5	26	25	25.5
Other conductors	2	15	13.6	14.5	18	16.5	18	26	24.5	26
Messengers	1.5	15	14.5	14	18	17.5	17.5	26	25.5	25.5
Surge protection wires	1.5	15	14.5	14	18	17.5	17.5	26	25.5	25.5
Guys:										
Grounded portions	1.5	15	14.5	14	18	17.5	17.5	26	25.5	25.5
Ungrounded portions	b	15	14.5	b	18	17.5	b	26	25.5	b
230E1 Neutral	1.5	15	14.5	14	18	17.5	17.5	26	25.5	25.5
Supply cables meeting:										
Rule 230C1; any voltage	1.5	15	14	14	18	17	17.5	26	25	25.5
Rule 230C2; 0 to 750 V	2	15	14	14.5	18	17	18	26	25	26
Rule 230C2; over 750 V	2.5	15	14	15	18	17	18.5	26	25	26.5
Rule 230C3; 0 to 750 V	2	15	14	14.5	18	17	18	26	25	26
Rule 230C3; over 750 V	2.5	15	14	15	18	17	18.5	26	25	26.5
Open supply conductors:										
0 to 300 V	2.5	15	13.5	15	18	16.5	18.5	26	24.6	26.
301 to 750 V	2.5	15	13.5	15	18	16.5	18.5	26	24.6	26.5
751 V to 22 kV	4.5	17	15.5	17	20	18.5	20.5	28	26.6	28.5
751 V to 8.7 kV										
8.7 kV to 22 kV										

[b]Clearances to ungrounded portions of guys are the same as required for the live conductors or parts to which they are exposed

[c]Intended to clear 16' rescue pole or vacuum skimmer pole plus person.

NS - Not Specified

NA - Not Applicable

AND 1990 CLEARANCES

32-1 and 232-2 Table 234-3

gory 7. Suitable for Sailboating 200 - 2000 Acres			Over 2000 Acres			Category 8. Clearances Over Rigging and Launching Areas	Clearances Passing By Swimming Areas A[c]			B		
87	87	90	87	87	90		87	87	90	87	87	90
30	30	30	36	36	36		18	18	20.5	14	14	12.5
60°	120° /ice	all	60°	120° /ice	all		60°	120° /ice	all	60°	120° /ice	all
NS	NA	NS	NS	NA	NS		NS	NA	NS	NS	NA	NS
NS	NA	NS	NS	NA	NS		NS	NA	NS	NS	NA	NS
same as required for the associated live part						Add five feet to the clearance required under Category 7 above associated waters.						
NS	NA	NS	NS	NA	NS		NS	NA	22.5	NS	NA	14.5
NS	NA	NS	NS	NA	NS		NS	NA	22.5	NS	NA	14.5
NS	NA	NS	NS	NA	NS		NS	NA	22.5	NS	NA	14.5
NS	NA	NS	NS	NA	NS		NS	NA	NS	NS	NA	NS
							NS	NA	NS	NS	NA	NS
32	31	31.5	38	37	37.5		18	17	22	14	13	14
32	30.5	32	38	36.5	38		18	16.5	22.5	14	12.5	14.5
32	31.5	31.5	38	37.5	37.5		18	17.5	22	14	13.5	14
32	31.5	31.5	38	37.5	37.5		18	17.5	22	14	13.5	b
32	31.5	31.5	38	37.5	37.5		18	17.5	22	14	13.5	14
32	31.5	b	38	37.5	b		18	17.5	b	14	13.5	b
32	31.5	31.5	38	37.5	37.5		18	17.5	22	14	13.5	14
32	31	31.5	38	37	37.5		18	17	22	14	13	14
32	31	32	38	37	38		18	17	22.5	14	13	14.5
32	31	32.5	38	37	38.5		25	24	23	16	15	15
32	31	32	38	37	38		18	17	22.5	14	13	14.5
32	31	32.5	38	37	38.5		25	24	23	16	15	15
32	30.5	32.5	38	36.5	38.5		25	22.5	23	16	15	15
32	30.5	32.5	38	36.5	38.5		25	22.5	23	16	14.5	17
34	32.5	34.5	40	38.5	40.5		25	23.5	25	16	14.5	17
							25	23.5	25	16	14.5	17

COMPARISON OF 1987

Clearances Passing By But Not Attached To:

Rule 234

Clearance From:	1990 M&E Component	Horizontal (feet, at 60°F) Building Walls, Projections and Roofs Not Accessible to Pedestrians			Balconies, Roofs and Areas Accessible to Pedestrians			Signs Etc.		
NESC Edition		87	90	90	87	87	90	87	90	90
Reference Component		5	0	3	5	0	3		0	3
Conductor loading		6# wind	6# wind	at rest	6 # wind	6# wind	at rest	6# wind	6# wind	at rest
Rigid Parts:										
Structures and arms	1	NS	NA	NS	NS	NA	NS	NS	NA	NS
Grounded metal	1	0	0	0	0	0	0	0	0	NS
Ungrounded metal					Clearances to ungrounded metal are the					
Unguarded Rigid Live Parts:										
0 to 150 V	2	5	NA	5	5	NA	5	5	NA	5
151 to 300 V	2	5	NA	5	5	NA	5	5	NA	5
301 to 750 V	2	5	NA	5	5	NA	5	5	NA	5
751 V to 8.7 kV	4	5	NA	7	5	NA	7	5	NA	7
8.7 kV to 22 kV	4	6	NA	7	6	NA	7	6	NA	7
Communication:										
Insul.cond. and cables	1.5	3	NS	4.5	3	NS	4.5	3	NS	4.5
Other conductors	2	3	NS	5	3	NS	5	3	NS	5
Messengers	1.5	3	NS	4.5	3	NS	4.5	3	NS	4.5
Surge protection wires	1.5	3	NS	4.5	3	NS	4.5	3	NS	4.5
Guys:										
Grounded portions	1.5	0.25	NS	4.5	3	NS	4.5	3	NS	4.5
Ungrounded portions	b	3	NS	b	3	NS	b	3	NS	b
230E1 Neutral	1.5	3	NS	4.5	3	NS	4.5	3	NS	4.5
Supply cables meetings:										
Rule 230C1: any voltage	1.5	3	NS	4.5	3	NS	4.5	3	NS	4.5
Rule 230C2: 0 to 750 V	2	3	NS	5	3	NS	5	3	NS	5
Rule 230C2: over 750 V	2.5	5[f]	3.5	5.5	5[f]	3.5	5.5	5[f]	3.5	5.5
Rule 230C3: 0 to 750 V	2	3	5	5	3	5	5	3	5	5
Rule 230C3: over 750 V	2.5	5[f]	3.5	5.5	5[f]	3.5	5.5	5[f]	3.5	5.
Open supply conductors:										
0 to 300 V	2.5	3[f]	3.5	5.5	5[f]	3.5	5.5	5[f]	3.5	5.5
301 to 750 V	2.5	5[f]	3.5	5.5	5[f]	3.5	5.5	5[f]	3.5	5.5
751 V to 8.7 kV	4.5	5[f]	4.5	7.5	5[f]	4.5	7.5	5[f]	4.5	7.5
8.7 kV to 22 kV	4.5	6[f]	4.5	7.5	6[f]	4.5	7.5	6[f]	4.5	7.5

[b]Clearances to ungrounded portions of guys are the same as required for the live conductors or parts to which they are exposed

[d]Does not meet the coordinated system.

[e]Only Horizontal Clearances apply to unguarded windows.

[f]Plus blowout conductor due to wind.

NS - Not Specified

NA - Not Applicable

Table 234-1.

Vertical (feet)

Building Walls, Projections and Roofs Not Accessible to Pedestrians			**Balconies, Roofs and Areas Accessible to Pedestrians**			**Trucks**			**No Trucks**			**Signs Etc.**		
87 9 60°	87 9 120° /ice	90 8 all	87 9 60°	87 9 120° /ice	90 9 all	87 14 60°	87 14 120° /ice	90 14 all	87 9 60°	87 9 120° /ice	90 9 all	87 9 60°	87 9 120° /ice	90 1.5/3.5 all
NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NA	4.5
0	0	NS	0	0	NS	0	0	NS	0	0	NS	0	0	4.5
same as required for the associated live part														
10	10	3.5[d]	12	12	11	18	18	16	12	12	11	5	NA	3.5[d]
10	10	3.5[d]	12	12	11	18	18	16	12	12	11	5	NA	3.5[d]
10	10	3.5[d]	15	15	11	18	18	16	15	15	11	5	NA	3.5[d]
10	10	12	15	15	13	20	20	18	20	20	15	8	NA	7.5
10	10	12	15	15	13	20	20	18	20	20	15	8	NA	7.5
3	2	3	8	7	10.5	18	17	15.5	10	9	10.5	3	2	3
3	1.6	3.5	8	6.5	11	18	16.5	16	10	8.5	11	3	1.5	3.5
3	2.5	3	8	7.5	10.5	18	17.5	15.5	10	9.5	10.5	3	2.5	3
3	2.5	3	8	7.5	10.5	18	17.5	15.5	10	9.5	10.5	3	2.5	3
3	2.5	3	8	7	10.5	18	17.5	15.5	10	9.5	10.5	3	2.5	3
2	2.5	b	8	7.5	b	18	17.5	b	10	9.5	b	3	2.5	b
3	2.5	3	8	7.5	10.5	18	17.5	15.5	10	9.5	10.5	3	2.5	3
3	2	3	8	7	10.5	18	17	15.6	10	9	10.5	3	2	3
3	2	3.5	8	7	11	18	17	16	10	9	11	3	2	3.5[d]
10	9	10.5	15	14	11.5	18	17	16.5	15	14	11.5	5	4	6
3	2	3.5	8	7	11	18	17	16	10	14	11	3	2	3.5[d]
10	9	10.5	15	14	11.5	18	17	16.5	15	14	11.5	5	4	6
10	8.6	10.5	12	10.5	11.5	18	16.5	16.5	12	10.5	11.5	5	3.5	6
10	8.6	10.5	15	13.5	11.5	18	16.5	16.5	15	13.5	11.5	5	3.5	6
10	8.6	12.5	15	13.5	13.5	20	18.5	18.5	20	18.5	13.5	8	6.5	8
10	8.6	12.5	15	13.5	13.5	20	18.5	18.5	20	18.5	13.5	8	6.5	8

Bridge Clearances:

Rule 234D, Table 2.

		Clearances Over Bridges						Clearances Beside, Under Readily		
		Attached			Not Attached			Attached		
NESC Edition		87	87	90	87	87	90	87	87	90
Reference Component		9	9	1	9	9	8		1	
Conductor Loading		60°	120° /ice	all	60°	120° /ice	all	60°	120° /ice	all[8]
Clearance From:	**1990 M&E Component**									
Rigid Parts:										
Structures and arms	1	NS	NA	NS	NS	NA	NS	NS	NA	NS
Grounded metal	1	0	0	NS	0	0	NS	0	0	NS
Ungrounded metal					Clearances to ungrounded metal are th.					
Unguarded Rigid Live Parts:										
0 to 150 V	2	3	3	3	10	10	10	NS	NA	3
151 to 300 V	2	3	3	3	10	10	10	NS	NA	3
301 to 750 V	2	4	3	3	10	10	10	NS	NA	3
751 V to 22 kV	4	5	5	5	10	10	12	NS	NA	5
Communication:										
Insul.cond. and cables	1.5	NS	NA	NS	NS	NA	NS	NS	NA	NS
Other conductors	2	NS	NA	3	NS	NA	10	NS	NA	3
Messengers	1.5	NA	NA	NS	NA	NA	NS	NA	NA	NS
Surge protection wires	1.5	NA	NA	NS	NA	NA	NS	NA	NA	NS
Guys:										
Grounded portions	1.5	NA	NA	NS	NA	NA	NS	NA	NA	NS
Ungrounded portions	b	NA	NA	b	NA	NA	b	NA	NA	b
230E1 Neutral	1.5	NA	NA	NS	NA	NA	NS	NA	NA	NS
Supply cables meetings:										
Rule 230C1; any voltage	1.5	NA	NA	NS	NA	NA	NS	NA	NA	NS
Rule 230C2; 0 to 750 V	2	3	2	3	10	9	10	3	2	3
Rule 230C2; over 750 V	2.5	3	2	3.5	10	9	10.5	3	2	3.5
Rule 230C3; 0 to 750 V	2	3	2	3	10	9	10	3	2	3
Rule 230C3; over 750 V	2.5	3	2	3.5	10	9	10.5	3	2	3.5
Open supply conductors:										
0 to 300 V	2.5	3	1.5	3.5	10	8.5	10.5	3	1.5	3.5
301 to 750 V	2.5	3	1.5	3.5	10	8.5	10.5	3	1.5	3.5
751 V to 8.7 kV	4.5	4	2.5	5.5	10	8.5	12.5	4	2.5	5.5
8.7 kV to 22 kV	4.5	5	3.5	5.5	10	8.5	12.5	5	3.5	5.

[b]Clearances to ungrounded portions of guys are the same as required for the live conductors or parts to which they are exposed

NS - Not Specified

NA - Not Applicable

[8]Vertical clearances are to exist at maximum sag or minimum sag, whichever is applicable. Horizontal clearances are to exist at rest under all applicable temperature conditions. For wind conditions, see Footnotes 8 and 9 of Table 234-2.

AND 1990 CLEARANCES

; and Rule 286F.

Under or Within Portions of Bridge Structures That Are:								
Accessible			Ordinarily Inaccessible					
Not Attached			Attached			Not Attached		
87	87	90	87	87	90	87	87	90
		3			1			2
60°	120° /ice	all[g]	60°	120° /ice	all[g]	60°	120° /ice	all[g]
NS	NA	NS	NS	NS	NS	NS	NA	NS
0	0	NS	0	0	NS	0	0	NS
ame as required for the associated live parts								
NS	NA	5	NS	NA	3	NS	NA	4
NS	NA	5	NS	NA	3	NS	NA	4
NS	NA	5	NS	NA	3	NS	NA	4
NS	NA	7	NS	NA	5	NS	NA	6
NS	NA	NS	NS	NA	NS	NS	NA	NS
NS	NA	5	NS	NA	NS	NS	NA	NS
NA	NA	NS	NA	NA	NS	NA	NA	NS
NA	NA	NS	NA	NA	NS	NA	NA	NS
NA	NA	NS	NA	NA	NS	NA	NA	NS
NA	NA	b	NA	NA	b	NA	NA	b
NS	NA	NA	NS	NA	NA	NS	NA	NA
NA	NA	NS	NA	NA	NS	NA	NA	NS
3	2	5	0.5	0	3	3	2	4
3	2	5.5	0.5	0	3.5	3	2	4.5
3	2	5	0.5	0	3	3	2	4
3	2	5.5	0.5	0	3.5	3	2	4.5
4	2.5	5.5	0.5	0	3.5	3	1.5	4.5
4	2.5	5.5	0.5	0	3.5	3	1.5	4.5
5	3.5	7.5	3	1.5	5.5	4	1.5	6.5
6	4.5	7.5	5	1.5	5.5	6	4.5	6.5

READER'S RACK

Schedule 40 "U"-guard

Rule 239G now allows all voltages to be run in non-metallic covering. Is Schedule 40 "U"-guard or plastic conduit acceptable for both primary and secondary risers? Is this based on a strength criteria or some other basis?

The NESC Clearances Subcommittee considered this question in light of a recent Interpretation and decided to leave that answer to the designer for two reasons. First, the required impact resistance and other attributes are site specific; for some locations almost any Schedule 40 PVC conduit or u-guard might do the job; for others, a heavier wall may be required.

Second, just as the old saying of "a rose is a rose is a rose" does not really apply to roses, neither does "Schedule 40" describe the attributes of a PVC conduit. There are several PVC conduits called Schedule 40 but having greatly different impact resistance, brittleness factors, electrical characteristics, etc.

It is up to the designer to choose a material having attributes appropriate for the expected conditions. Since normal practice is to utilize a backer plate with u-guards to keep pole treatment from damaging the higher voltage cables, the Subcommittee choose to be silent on differentiating between conduits and u-guards for many applications.

For purposes of Rule 239G3, conduits and u-guards are not differentiated.

Allen L. Clapp

The workshop leader is Allen L. Clapp, P.E., R.L.S., President of Clapp Research Associates, P.C., a small, multidisciplinary consulting group of engineers and scientists serving over 100 utilities and industries. Over 10,000 people have attended Allen's DANESC™ Seminars on the Development and Application of the NESC.

Mr. Clapp is Chairman of the National Electrical Safety Code Committee and a member of the following subcommittees: Executive (Chairman); Interpretations (Past Chairman); Strength and Loadings (Secretary); Clearances (Past Acting Secretary); and Scope, Application, and Definitions (Past Secretary). He has served continuously on NESC technical subcommittees since 1971 and has chaired a number of special working groups.

Allen Clapp is author of the *NESC Handbook*™ published by the Institute of Electrical and Electronics Engineers. The DANESC™ Seminars are an outgrowth of the years of research by Mr. Clapp in preparation of the *NESC Handbook*. He also edits and publishes DANESC™ **UPDATE Newsletter** which provides in-depth treatment to practical problems in meeting the NESC requirements under various conditions. Mr. Clapp heads the IEEE NESC Lecture team and frequently presents live DANESC™ Seminars for his utility-related clients. Allen has thousands of speaker-hours of experience; he regularly changes pace and uses appropriate humor or pathos to stimulate the interest of seminar participants.

Mr. Clapp is a contributor to McGraw-Hill's *Standard Handbook for Electrical Engineers*; a member of the National Safety Council, the American National Standards Institute, and the American Society of Safety Engineers; a nationally recognized lecturer; and an active member of the IEEE and the Power Engineering Society. He is a past member of the IEEE Standards Board, Past President of the Professional

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OJ-11

EXHIBIT 6

TFC T10625 Plain
(0.625" Bare Al CATV Cable)
0.25" EHS Strand, Single Lashed

Initial Sag (inches)

Span Length (Feet)	Strand and Cable Ambient Air Temperature												Strand With No Cable		
	0°F	10°F	20°F	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	30°F	60°F	90°F
100	12	13	14	15	16	17	18	19	20	21	21	23	13	17	19
125	16	17	18	19	20	21	23	24	25	26	27	29	16	21	24
150	19	20	22	23	24	26	27	28	30	31	32	34	19	25	28
175	23	24	26	27	29	30	32	33	34	36	37	40	21	28	32
200	26	28	30	31	33	34	36	38	39	41	42	45	24	32	36
225	30	32	34	35	37	39	41	42	44	46	47	51	27	35	40
250	34	36	38	39	41	43	45	47	49	51	52	56	29	38	43
275	38	40	42	44	45	47	50	52	53	55	57	61	32	41	47
300	42	44	46	48	50	52	54	56	58	60	62	67	34	44	50

Final Sag (inches)
(No Wind)

Span Length (Feet)	Conductor Temperature												0.5" Ice	0.0" Ice	
	0°F	10°F	20°F	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	32°F	32°F	86°F
100	23	24	25	26	26	27	28	28	29	30	30	32	30	26	29
125	29	30	31	32	33	34	34	35	36	37	38	39	38	32	37
150	35	36	37	41	39	40	41	42	43	44	45	47	47	42	44
175	40	-42	43	44	45	47	48	49	50	51	52	54	55	44	51
200	46	47	49	50	52	53	54	55	57	58	59	62	64	50	57
225	51	53	55	56	58	59	61	62	63	65	66	69	74	56	64
250	57	59	60	62	64	65	67	69	70	72	73	76	83	62	71
275	62	64	66	68	70	71	73	75	77	78	80	83	92	68	78
300	68	70	72	74	76	78	79	81	83	85	87	90	102	74	84

This table is applicable for 1993 NESC Heavy Loading Districts

TFC T10875 Plain
(0.875" Bare Al CATV Cable)
0.25" EHS Strand, Single Lashed

Initial Sag (inches)

Span Length (Feet)	Strand and Cable Ambient Air Temperature												Strand With No Cable		
	0°F	10°F	20°F	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	30°F	60°F	90°F
100	13	14	14	15	16	17	18	19	20	21	21	23	11	16	18
125	16	17	18	19	20	21	23	24	25	26	26	28	14	19	22
150	20	21	22	23	25	26	27	28	29	30	32	34	15	22	25
175	24	25	26	28	30	30	32	33	34	35	37	39	17	24	28
200	28	29	30	32	33	35	36	37	39	40	42	44	19	27	31
225	32	33	34	36	37	39	41	42	44	45	47	50	20	29	33
250	35	37	39	40	42	43	45	47	48	50	52	55	22	31	36
275	39	41	43	44	46	48	50	51	53	55	57	60	24	32	38
300	43	45	47	49	50	52	54	56	58	60	61	65	25	34	40

Final Sag (inches)
(No Wind)

Span Length (Feet)	Conductor Temperature												0.5" Ice 32°F	0.0" Ice 32°F	86°F
	0°F	10°F	20°F	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F			
100	23	24	25	25	26	27	27	28	29	29	30	31	30	26	29
125	29	30	31	31	32	33	34	35	36	36	37	39	39	32	36
150	34	35	36	37	38	39	40	41	42	43	44	46	47	38	43
175	40	41	42	43	45	46	47	48	49	50	51	53	56	44	50
200	45	47	48	49	51	52	53	54	56	57	58	60	65	49	56
225	50	52	53	55	56	58	59	61	62	63	65	67	74	55	63
250	56	57	59	61	62	64	65	67	68	70	71	74	84	61	69
275	61	63	64	66	68	70	71	73	75	76	78	81	94	67	76
300	66	68	70	72	74	75	77	79	81	83	84	88	103	72	82

This table is applicable for 1993 NESC Heavy Loading Districts

TECHNICAL NOTE / 1064-12A

TFC 1-T10625 Plain & 1-T10875 Plain (0.625" & 0.875" Bare Al CATV Cable) 0.25" EHS Strand, Double Lashed

Initial Sag (inches)

Span Length (Feet)	Strand and Cable Ambient Air Temperature 0°F	10°F	20°F	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	Strand With No Cable 30°F	60°F	90°F
100	13	14	15	16	16	17	18	19	20	20	21	23	10	14	17
125	17	18	19	20	21	22	23	23	24	25	26	28	11	17	20
150	21	22	23	24	25	26	27	28	29	30	31	33	12	18	22
175	25	26	27	28	29	30	32	33	34	35	36	39	13	20	24
200	29	30	31	32	33	35	36	37	39	40	41	44	14	21	25
225	33	34	35	36	38	39	41	42	43	45	46	49	15	22	26
250	37	38	39	41	42	44	45	46	48	49	51	54	16	23	27
275	41	42	44	45	46	48	50	51	53	54	56	59	17	24	28
300	45	46	48	49	51	52	54	56	57	59	61	64	18	25	29

Final Sag (inches) (No Wind)

Span Length (Feet)	Conductor Temperature 0°F	10°F	20°F	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	0.5" Ice 32°F	0.0" Ice 32°F	86°F
100	23	24	24	25	26	26	27	28	28	29	30	31	31	25	29
125	28	29	30	35	32	33	34	34	35	36	37	38	40	36	36
150	34	35	36	37	38	39	40	41	42	43	44	45	49	37	42
175	39	40	41	43	44	45	46	47	48	49	50	52	59	43	49
200	44	46	47	48	50	51	52	53	54	56	57	59	68	48	55
225	50	51	52	54	55	57	58	59	61	62	63	66	78	54	61
250	55	56	58	59	61	62	64	65	67	68	69	72	88	60	67
275	60	61	63	65	66	68	69	71	73	74	76	79	98	65	73
300	65	66	68	70	72	73	75	77	78	80	82	85	116	70	79

This table is applicable for 1993 NESC Heavy Loading Districts

TFC 2-T10625 Plain & 1-T10875 Plain (0.625" & 0.875" Bare Al CATV Cable) 0.25" EHS Strand, Single Lashed

Initial Sag (inches)

Span Length (Feet)	Strand and Cable Ambient Air Temperature 0°F	10°F	20°F	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	Strand With No Cable 30°F	60°F	90°F
100	14	14	15	16	16	17	18	19	20	20	21	22	8	13	15
125	17	18	19	20	21	22	23	23	24	25	26	28	9	14	17
150	21	22	23	24	25	26	27	28	29	30	31	33	9	15	18
175	25	26	27	28	29	30	32	33	34	35	36	38	10	15	19
200	29	30	31	33	34	35	36	37	38	40	41	43	11	16	19
225	33	35	36	37	38	39	41	42	43	44	46	48	12	16	20
250	38	39	40	41	42	44	45	46	48	49	50	53	12	17	20
275	42	43	44	46	47	48	50	51	52	54	55	58	13	17	20
300	46	47	49	50	51	53	54	55	57	58	60	63	14	18	21

Final Sag (inches)
(No Wind)

Span Length (Feet)	Conductor Temperature 0°F	10°F	20°F	30°F	40°F	50°F	60°F	70°F	80°F	90°F	100°F	120°F	0.5" Ice 32°F	0.0" Ice 32°F	86°F
100	23	23	24	25	26	26	27	27	28	29	29	31	31	25	28
125	28	29	30	31	31	32	33	34	35	35	36	38	40	31	35
150	33	34	35	36	37	38	39	40	41	42	43	45	49	37	42
175	39	40	41	42	43	44	45	46	47	48	49	51	58	42	48
200	44	45	46	47	49	50	51	52	53	54	56	58	67	48	54
225	49	50	51	53	54	55	57	58	59	60	62	64	77	53	60
250	54	55	57	58	59	61	62	64	65	66	68	71	87	58	66
275	59	60	62	63	65	66	68	69	71	72	74	77	97	64	72
300	64	65	67	68	70	72	73	75	76	78	79	83	107	69	77

This table is applicable for 1993 NESC Heavy Loading Districts